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CARBON RATIONING AND PERSONAL ENERGY USE

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ABSTRACT

A new policy approach is needed to deliver carbon dioxide savings in the UK; this paper proposes carbon rationing for personal energy use. Current policies are extremely unlikely to result in sufficient savings to meet the 2010 national reduction target. Indeed, when international air travel emissions are included, carbon equivalent emissions have not actually fallen since 1990. In the domestic sector, energy efficiency is expected to deliver significant carbon savings, but data from recent decades show this to be a triumph of hope over experience. Instead carbon rations for personal transport and household energy use are suggested. Rations would be equal, tradable, mandatory and would decrease year-on-year. The aim would be to make guaranteed carbon savings in an egalitarian way. Practical details of rationing are outlined and concerns about its effects are debated. Finally, it is concluded that rationing has great potential to enable the UK, and other countries, to meet their carbon saving targets.

INTRODUCTION

Climate change is widely recognised at the most serious environmental problem facing the world. Some would suggest it is most serious problem of any kind, for example the UK government's chief scientist, David King, said that: "climate change is the most severe problem that we are facing today - more serious even than the threat of terrorism" (King 2004). Research news about climate change and its expected effects has, if anything, become more alarming since the 2001 IPCC report which projected possible temperature increases by 2100 of up to 5.8 degrees Celcius (IPCC 2001). For example, two different studies from the UK Hadley Centre have suggested that increased carbon dioxide concentrations in the atmosphere may lead to higher temperature rises than those reported in IPCC's work (Clarke 2003; Murphy et al 2004). In addition, there are concerns that the effects of climate change are beginning to be seen before scientists had expected, and even that positive feedbacks in the climate system, which could accelerate global warming are starting to be detected (Vidal 2004). This is the very serious global backdrop to the analysis presented here about how to reduce carbon emissions in the UK.

This paper focuses on the domestic sector and energy use for personal transport in the UK. First of all, the fall in UK carbon emissions over recent years is described, as is the effect of including international air travel emissions in the analysis. It is argued that the current key strategy for energy and carbon savings in the domestic sector, energy efficiency, cannot be relied upon to deliver. Instead a new approach is needed, which fully recognises the global limits that climate change places on carbon dioxide emissions to the atmosphere. This approach is carbon rationing, a policy which described in some detail, as are the policy innovations which might arise to make carbon rationing successful.

INTERNATIONAL AND UK RESPONSE

Frameworks for greenhouse gas reductions

The world's governments responded to the threat of climate change by creating the United Nations Framework Convention on Climate Change (UNFCCC), whose objective of "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference

with the climate system" was put into action through the Kyoto Protocol (UN 1992; UN 1997). The net effect of Kyoto, if the targets are met, will be to reduce industrialised countries' emissions by at most 5%. The limited ambitions of Kyoto, the disappointing exit of the USA from the process and the slow progress in ratifying the protocol have been widely recognised.

Within Europe Kyoto still represents a very challenging target, the Member States of the EU having jointly agreed to undertake an 8% reduction of six key greenhouse gases by 2010. The UK's Kyoto target is a reduction of 12.5% from 1990 levels by 2010. In addition, the UK has set itself a national target for a reduction of 20% by 2010 from carbon dioxide emissions in 1990. It has also declared that it is aiming for a 60% reduction by 2050, based on work carried out by the Royal Commission on Environmental Pollution which identified this as the saving the UK would have to make within a global agreement to cap atmospheric carbon dioxide concentrations at 550ppm (RCEP 2000). This target represents an important advance on Kyoto, and no other country has set such an ambitious long-term target.

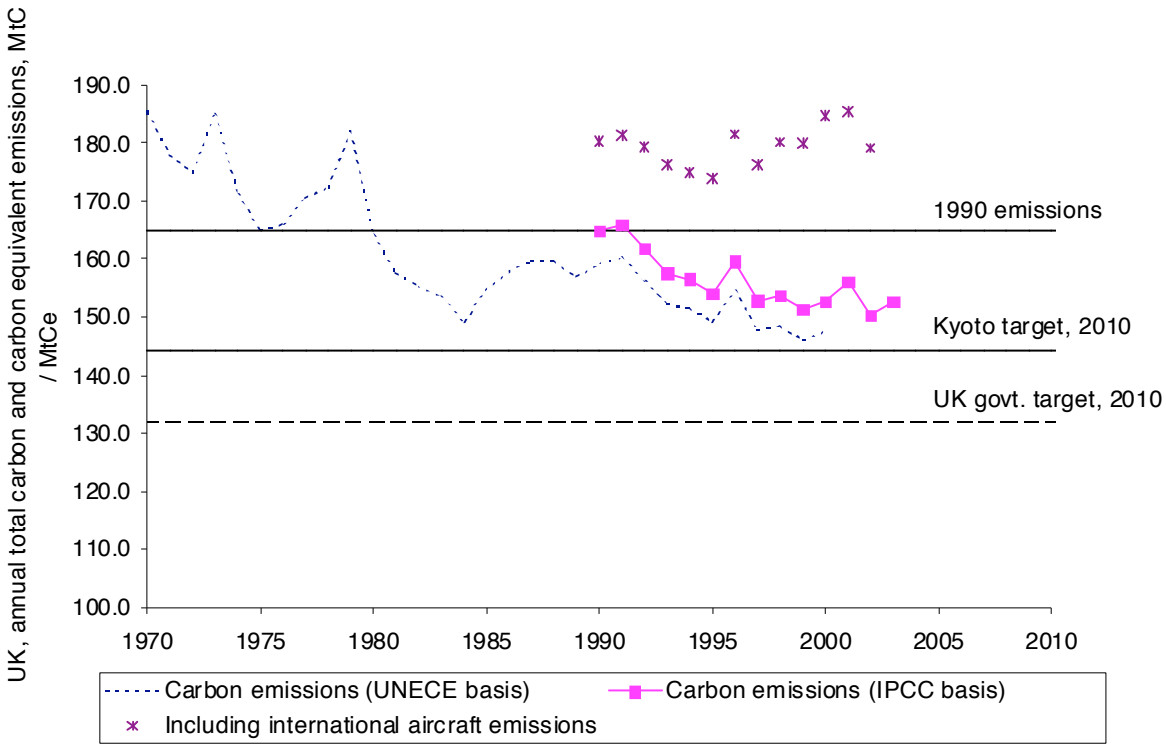
Progress with emissions reduction

Worldwide greenhouse gas and carbon dioxide emissions continue to rise, and levels of carbon dioxide in the atmosphere are increasing (Marland et al 2003). The atmospheric concentration of CO_2 increased from 354ppm in 1990 to 376 ppm in 2003 (Keeling and Whorf 2004).

Contrary to experience in most countries, UK carbon dioxide emissions have fallen in recent years (see figure 1). This is in spite of rising energy demand – primary energy demand rose by 10.8% between 1970 and 2003 (DTI 2004). However, only limited encouragement can be taken from this fall in emissions. Firstly, much of the UK's emissions reduction since 1990 is due to a switch towards lower carbon fuels (primarily gas and nuclear power) which cannot be repeated in future, rather than a fundamental transformation towards a lower carbon economy (Eichhammer et al 2001). Secondly, when international airline emissions are taken into account, UK emissions have not actually fallen since 1990, as demonstrated below.

Figure 1 shows two sets of official carbon dioxide emissions data. For earlier years, the only UK figures available are calculated on an UNECE basis (UNECE 2001). However, current official UK estimates of greenhouse gas emissions are calculated in line with IPCC reporting guidelines, and figures are available on this basis are available from 1990 onwards (Houghton et al 1996). The difference between the two methods of calculation is relatively small – but neither methodology includes emissions from international aviation. IPCC figures do include domestic emissions from aviation, which have been estimated at 5% of UK aviation emissions, the other 95% being from international travel (Bishop and Grayling 2003).

Figure 1: Carbon dioxide emissions from the UK, including international aircraft carbon equivalent emissions, 1970-2003



To add in emissions from international aviation, carbon dioxide data from 1990 onwards can use used (ONS 2004). Importantly, aircraft emissions add more powerfully to the greenhouse effect than the carbon dioxide component alone. The current best estimate is that they have three times the effect of carbon dioxide per tonne of CO_2 emitted (RCEP 2002). When international airline carbon equivalent emissions are added to UK carbon emissions (IPCC methodology), there is little difference in total emissions for 1990 and 2002. This gives a less rosy, but more realistic, view of the UK's progress on reducing carbon dioxide emissions. It also highlights the importance of international airline emissions.

Future prospects

In the EU, the latest assessment is that ten of the fifteen pre-2004 Member States are likely to miss them by a wide margin (the ten new EU member states which joined in 2004 do not have commitments within the EU envelope) (Gugele et al 2003). Even those countries which were allowed significant increases in emissions under the EU burden-sharing arrangements, including Portugal, Spain and the Republic of Ireland are not on track to meet their commitments.

In contrast to most of its European partners, the UK is on track to meet its Kyoto target (Gugele et al 2003) and is widely expected to meet the target in 2010 (IEA 2002a; EEA 2003). However, there is a substantial body of opinion which doubts the 20% target by 2010 can be met given the current policy measures. The Sustainable Development Commission (SDC)suggested that emissions of CO_2 will fall by at most only 12.6% by 2010, and perhaps substantially less (SDC 2003). Perhaps surprisingly, provisional forecasts by the Department of Trade and Industry (DTI) also suggest that the government is badly off course for its 2010 CO_2 reduction target (DTI 2003). This discussion of future prospects excludes the effect of international aviation, which is expected by the Department for Transport (DfT) to continue growing rapidly, with passenger numbers using UK airports on course to triple by 2030 (DfT 2003a).

At present, despite the pledges and aspirations of the UNFCCC, the world is heading on the path towards six degrees Celcius or more of global warming within the next one hundred years. The UK's carbon emissions have reduced since 1970, however, the UK will have to work harder to achieve future

emissions because fortuitous reductions will not happen on the same scale again. In addition, much of the perceived fall is illusory, because rapidly increasing international air travel emissions are not included in official statistics. Although the UK has adopted ambitious long-term and shorter-term carbon reduction goals, at the same time, decisions which can only lead to increases in carbon dioxide emissions, such as expanding airport capacity to facilitate an increase in air travel, are still being taken (DfT 2003a).

UK DOMESTIC SECTOR POLICY: BUILDING ON PAST FAILURE?

Energy consumption in the UK domestic sector is rising. Despite many changes in technology and ownership of household equipment since 1970, patterns of energy use by end use have changed relatively little and the average energy consumption per household has remained about the same (Shorrock and Utley 2003). Considerable improvements in energy efficiency have not led to net energy savings because other factors, such as higher ownership of central heating and increasing indoor temperatures, led to increases in energy services over the same period. Increasing household numbers have resulted in rising consumption overall.

There are a number of arguments which throw doubt on the theoretical effectiveness of energy efficiency (Herring 2000), but probably the most convincing evidence is the experience of the UK domestic sector over the past thirty years, where net reductions in energy consumption have not been made. This is not to doubt that considerable technological improvements are still possible. There are many studies which have identified possible energy and carbon savings from domestic energy efficiency (e.g. ICCEPT 2002; Johnston 2003; Fawcett et al 2000). However, very similar projections were produced, using very similar assumptions, in earlier decades (e.g. Leach et al 1979). The savings hoped for did not materialise, and all past experience shows that even if efficiency can be increased, it will not guarantee lower energy use.

Improving energy efficiency has been, and remains, the dominant government strategy for energy and carbon savings in the domestic sector. The DEFRA Report *Energy efficiency: the government's plan for action* identifies the carbon savings expected to be achieved in each sector and key risks for delivery of energy efficiency goals are identified (DEFRA 2004a). Overall, DEFRA suggests that there is a 'medium' risk that energy efficiency measures will not deliver the required carbon savings. Experience over the past thirty years would suggest instead that in reality there is a very high risk that carbon savings will not delivered through efficiency alone. This conclusion has also been reached by other researchers considering international experience beyond the UK (Wilhite and Norgard 2003). It is time to consider a new approach.

A NEW POLICY APPROACH: PERSONAL CARBON RATIONING

The solution suggested here to guarantee carbon reductions from the domestic sector is personal carbon rationing. Personal carbon rationing would be a UK-wide allowance system covering carbon emissions generated from fossil fuel energy used by individuals for personal transport, including carbon equivalent emissions from air travel, and within the home. It would account for around half of current UK carbon emissions from energy, including `air travel. The primary aim of the scheme would be to deliver guaranteed levels of carbon savings in successive years. It could be used to achieve the government's current target of 60% reduction by 2050 or whatever alternative targets are deemed necessary as time progresses. It could apply equally well as a national response in other countries. Carbon rations could equally well be described as 'allowances', 'entitlements' or 'quotas', but the word 'ration' is used for clarity and consistency.

The most prominent UK proponent of carbon rationing is Mayer Hillman. He has been developing and promoting the idea of personal carbon rations for several years (Hillman 1998). The description of rationing here was developed both independently by the author and in partnership with Hillman (Fawcett 2003; Hillman and Fawcett 2004).

The international context for national carbon rationing

Personal carbon rationing as a UK solution emerges from the key proposed global solution to climate change: 'contraction and convergence'. Contraction and convergence (C&C) was first proposed by the Global Commons Institute in 1990 (Meyer 2000). C&C is founded on two fundamental principles: first, that the global emission of greenhouse gases must be progressively reduced; secondly, that global governance must be based on justice and fairness.

C&C consists of:

Contraction: An international agreement is reached on how much further the level of CO_2 in the atmosphere can be allowed to rise before the changes in the climate it produces will become totally unacceptable. Once this limit has been agreed, it is possible to work out how quickly current global emissions must be cut back to avoid exceeding the limit. This cutting back is the contraction part of contraction and convergence.

Convergence: Global convergence to equal per capita shares of this contraction, by an agreed year.

C&C is considered by many to be the framework which should succeed the current Kyoto agreement. It has many influential supporters, including the UN Environment Programme and the European Parliament (Pearce 2002). The UK government, has so far refused to endorse C&C, but it has not identified its preferred post-Kyoto framework.

A detailed description of carbon rationing

The main features of carbon rationing would be:

- Equal rations for all individuals
- Tradable rations
- Year-on-year reduction of the annual ration, signalled well in advance
- Personal transport and household energy use included
- A mandatory, not voluntary arrangement

Equal rations

Carbon rationing will be based on equal carbon rations for all adults. Children would probably receive somewhat less than the adult ration – because their emissions are likely to be lower on average. Within a scheme of equal rations, it might be thought necessary to give additional rations to some classes of vulnerable people (e.g. the elderly or fuel poor). However, in the longer term it would make far more sense for the government to subsidise efficiency and/or renewable energy measures for certain classes of people rather than grant them extra allowances. The more exceptions that are made, the lower will be the available ration for everyone else.

A concern for equity is one of the key motives for proposing national carbon rationing based on equal shares. Preliminary analysis showed that carbon rationing has a redistributive aspect, with individuals in lower income households having lower emissions on average than those in wealthier households (Fawcett 2003). But rationing is not being introduced in order to resolve existing inequities in access to energy services within society.

Equal rations are based on the principle of equity, where equity is defined in an egalitarian way as giving people equal rights to pollute. This is the same principle as that which underlies contraction and convergence. Alternative definitions of equity do exist, these include ability to pay rules (varying according to national well-being) and polluter pays - where abatement costs are distributed in proportion to emission levels (IEA 2002b). However, an equal right to pollute is considered here to be the most defensible and manifestly fair way of sharing out the UK's emissions total between individuals.

Tradable rations

The carbon ration necessary to cover current consumption will vary considerably between individuals. Those who invest in household efficiency and renewables, travel less, and who lead lives with a lower energy input, will not need all of their ration and will therefore have a surplus to sell. Those who travel a lot, or who live in large or inefficient homes will need to buy this surplus to permit them to continue with something like their accustomed lifestyle. Thus people will want to trade carbon and trading would be an integral part of a carbon rationing scheme. In addition, by incorporating trading within the rationing scheme, economic theory says that savings should be made at least overall cost.

The question arises, does having trading as part of the system undermine its egalitarian credentials? Certainly, in the early years of its introduction, well-off people will be able to buy the surplus from those who lead energy-thrifty lifestyles. But the cost of doing so will rise steadily as the ration is progressively reduced. Nobody would be forced to sell their ration, and if people do choose to sell some of their rations, they will gain financially. So, while it is true that trading allows wealthier people to lead a higher carbon lifestyle if they choose, this does not undermine the basic equality of the rationing system.

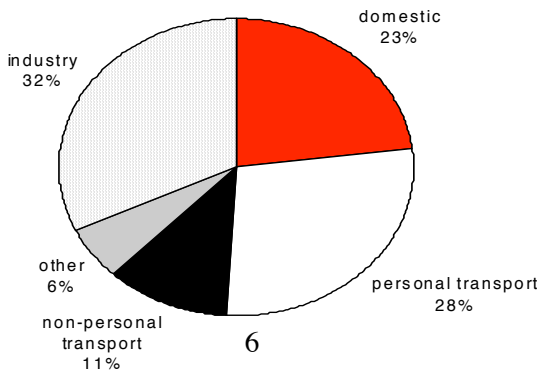
The boundaries of personal carbon rations

Personal carbon rations would cover all household energy use and personal transport energy use including air travel, that is, all direct use of energy by individuals. There are a number of good reasons for including both personal transport and household carbon emissions. Firstly, as demonstrated below, by including both, half of the energy-related carbon and carbon equivalent emissions in the UK economy would be covered. Secondly, reducing emissions in the transport sector is unlikely to be any easier than in the residential sector and a mechanism to cap and reduce emissions in this sector will be certainly be required: rationing is just as relevant as for household energy (Hillman and Fawcett 2004). Thirdly, combining personal transport and household energy use in a single scheme would give people flexibility in responding to carbon restrictions.

The UK government publishes figures which split total carbon emissions between industrial, domestic, transport and other sectors (DEFRA 2004b). Official statistics are not split by personal and business / freight transport. However, it is possible to make estimates of this split using the best available data about the proportion of road and air travel used for personal as opposed to business reasons (DTI 2004; DEFRA 2001; DfT 2003b).

Figure 2: Percentage of UK carbon emissions (including carbon equivalent emissions from international air travel) by sector, 2001

This gives an estimated total of 51% of UK carbon and carbon equivalent emissions directly under the control of individuals, through their personal travel and household energy use. The average individual's personal carbon and carbon equivalent emissions are made up of 45% from household energy use, 27% from air travel, and 28% from all other modes of transport.



Reducing rations

UK carbon rations will have to decrease over time, in response both to the need to reduce global emissions and to allow for the expected rise in national population. The level of future rations depends on what cuts need to be made to ensure that the agreed level of carbon dioxide emissions in the atmosphere is not exceeded. It also depends to a lesser extent on the date chosen for global convergence on equal emission rights. A national reduction of 60% by 2050 (designed to stabilise concentrations at 550ppm), would result in personal rations falling by a little more than 60% from today's average, to allow for the expected growth in the UK population. If a more risk-averse target for maximum atmospheric carbon dioxide concentration of 450ppm was chosen, then the reductions needed by 2050 would be around 80%.

These proposed carbon reductions will have real consequences, particularly for international air travel. (If the government's 60% target is met, this will be true whether or not carbon rationing is adopted as the mechanism to make the savings.) Under the 450ppmv scenario, just one return flight from London to Athens would exceed the whole personal carbon ration for the year in 2030. In the 550ppmv scenario, a return flight from London to New York would exceed the annual ration by 2030 (Hillman and Fawcett 2004). Stabilising carbon dioxide concentrations — at any level — requires the eventual reduction of global carbon dioxide emissions to a fraction of their current levels (IPCC 2001). So, whatever the atmospheric concentration target for 2050, to prevent it being breached thereafter carbon rations will have to continue to fall from 2050 into the future.

Mandatory

In order to be effective, carbon rationing would have to be mandatory. A voluntary approach would not succeed: the 'free-rider' would have far too much to gain. As Michael Jacobs has written:

> *…environmentally sustainable consumption will not come about through individual choices, but through regulatory policies collectively decided and imposed through the state. … Admirable as voluntary reductions in consumption are, they are not the route to environmental improvement. (Jacobs 1997)*

A related policy proposal: Domestic tradable quotas

A detailed approach to carbon saving across the whole economy has been developed, and this has a great deal in common with carbon rationing (Starkey and Fleming 1999). Starkey and Fleming's proposal is called 'Domestic Tradable Quotas' (DTQs) – where domestic indicates a national as opposed to an international scheme. The basis of the policy is that the national government sets an overall carbon budget that is reduced over time. The 'carbon units' making up this budget are issued to adults and organisations. All adults receive an equal and unconditional entitlement of carbon units; organisations acquire the units they need from a tender, a form of auction modelled on the issue of government debt. There is a national market in carbon units in which low users can sell their surplus and higher users can buy more. Starkey and Fleming claim that the scheme would be effective, equitable and efficient. This work is being developed further under the Tyndall Centre 'Decarbonising modern societies' programme by Anderson and Starkey (2004).

This research has attracted some political attention, on 6th July 2004 Colin Challen MP introduced a private member's bill entitled *Domestic tradable quotas (carbon emissions)* (Hansard 2004). The aim of the bill is to introduce a national trading scheme for carbon emissions and to set a national ceiling for carbon emissions. The bill is scheduled for a second reading in October 2004, however it is thought to have little chance of becoming law (Press Association 2004). Nevertheless, the beginning of interest in rationing-type schemes is encouraging.

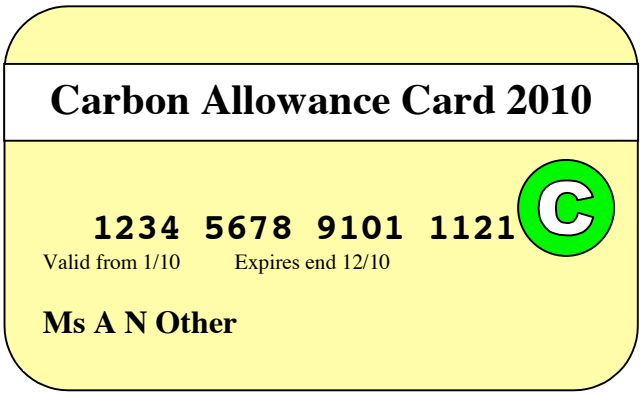
CARBON RATIONING AS A PRACTICAL POLICY

Below I discuss some of the practical aspects of introducing carbon rationing. Many social, technical and policy innovations would be needed to make it easier for people to live within their carbon rations - some ideas about what these might be are outlined.

Administration

Administration of carbon rationing should be straightforward. Each person would get an electronic card containing that year's carbon credits. The card would have to be presented on purchase of energy or travel services, and the correct amount of carbon would be deducted. The technologies and systems already in place for direct debit systems and credit cards could be used. The technical feasibility of managing carbon allowances electronically is discussed in greater detail for DTQs, and is being researched further by Anderson and Starkey (2004).

Figure 3: Illustration of a possible future carbon allowance card



There are relatively few sellers of gas, electricity, petrol, diesel and other fuels, and flows of fossil fuels are already very well recorded and tightly regulated in the economy. Introduction of such an allowance scheme therefore would affect few businesses, and those involved would be large businesses with the capability to adapt.

Making awareness of carbon emissions part of everyday life

There is currently little information available to consumers, householders and travellers about the carbon impacts of their decisions. One exception is that carbon emission figures per kilometre are published in advertising material for new cars. In addition, there are plans at an EU level to include carbon emission figures on energy bills (Boardman and Palmer 2003). However, with carbon rationing, carbon becomes a parallel currency and the level of information and education on carbon issues will have to increase considerably.

The following suggestions are some of the ways in which the carbon impacts of decisions could be made more transparent:

- smart bills: including carbon emissions on gas, electricity, fuel oil and other fuel bills;
- smart meters: gas and electricity meters to be upgraded over time to include a running total of carbon emissions, and provide comparisons with previous periods;
- enhanced petrol pumps: displaying carbon emissions as well as price and quantity ;
- 'carbon-ometers': adding a carbon counter to standard car, motorcycle and moped displays, allowing the driver to have a record of total carbon emissions, plus a trip carbon calculator (as is equivalently available on the mileometer);

- carbon responsibility in advertising: all flight tickets and travel promotional material to include equivalent carbon emissions;
- carbon labels: energy labels on appliances and light bulbs to include average annual carbon emissions;
- carbon-rated homes: all houses, new and old, to be sold with an energy survey and an estimate of average annual carbon emissions in use, plus tailored advice on how to reduce the emissions. Tenants would also need carbon information from their landlords.

Some of these ideas could be introduced by extending existing information provision methods, for example the existing EU energy labels which are already present on cold appliances, laundry appliances, dishwashers and light bulbs. Under carbon rationing, people would need to know the carbon implications of buying a new piece of energy-using equipment. Carbon rations would fit much better with energy labels based on absolute consumption rather than relative efficiency, the basis for the current scheme. A small, less efficient fridge might be a lower carbon choice than a larger, more efficient one. So the current labelling systems would need to be adjusted to meet the new low carbon imperative.

New businesses and public sector organisations would also be expected to emerge to meet people's need to manage their carbon emissions, and existing organisations would take on new roles. One possible new organisation would be 'CarbonWatchers' - a community information and support scheme equivalent to diet schemes such as WeightWatchers (Hillman and Fawcett 2004). Based on the diet clubs template, it would provide its members with booklets / electronic information explaining the carbon impacts of different purchases and travel options, set reduction targets for individuals, hold regular audits (the equivalent of weigh-ins) and provide both professional and peer support for participants.

Providing a framework

One of the key benefits of carbon rationing is that it provides a framework for carbon reductions. No longer might it be necessary to have separate government policies and programmes to promote everything from cycling strategies to efficient refrigerators. Under carbon rationing, the carbon 'market' should recognise the benefits of renewable energy, household insulation and low carbon methods of transport. Under carbon rationing, many people may choose to meet all their carbon reductions through technical improvements such as more efficient homes and energy-using equipment. Carbon rationing allows people to reduce their emissions in the way that suits them best, whether through technical efficiency improvements and using more renewable energy or through demanding fewer energy services, or any combination of these strategies. But without carbon rationing there would be no framework for ensuring that they did so.

PROBLEMS WITH CARBON RATIONING

Several potential problems with rationing have been raised at presentations and in discussions with various audiences. One of the most frequent questions is 'how do we get from here to there?' In other words, how can the perceived gulf between the present world and the radical changes that would be required under carbon rationing be bridged? Other common themes are: how will people cope?; individual responsibility; the role of goods and services within carbon rationing.

The gap between present policy and carbon rationing

There is no doubt that carbon rationing presents a very different philosophical approach to making savings in the domestic sector and transport sectors at present. Some steps for easing the transition towards carbon rationing are suggested.

Educating the public

Prior to introducing carbon rationing, there would need to be a education and persuasion campaign to ensure that it would have sufficient public support. This would be a huge task. In general the sorts of

initiative which will be required include: making carbon consumption more visible at the point of energy purchase; helping people understand their responsibility for climate change; giving information so that people can make lower carbon choices. Hillman and Fawcett (2004) argues that a key step is for people to undertake their own carbon audits, so they understand in some detail their own carbon emission patterns, and begin to identify priority areas for carbon reduction.

Adapting existing policies

As identified earlier, policies currently oriented towards promoting energy efficiency could be adapted to enable carbon saving. Under carbon rationing, the rationing scheme itself should provide all the incentive that individuals would need to search out the lower carbon energy supplies, lower energy using products and services and so on. All that the government should need to do is ensure that information, advice and education is provided such that people are able to distinguish between the carbon implications of their consumption decisions.

Easing the introduction of rationing

The nature of carbon rationing is such that it could not sensibly be introduced on either a regional or a voluntary basis to test its efficacy. It would need to be introduced nationally and in a mandatory way. However, there would be ways of simplifying the introduction of carbon rationing to reduce initial complexity and confusion. For example, carbon rationing could be initially introduced with no annual reductions to give people time to understand and start adjusting to the new system. Also, public transport journeys could be excluded from carbon rationing at first as these account for only a small percentage of road transport emissions.

How will people cope?

One of the big concerns about carbon rationing is how people will cope with this new method of restricting their (fossil fuel) energy use. A common question is what would happen if people ran out of their ration before the end of the year - would this mean that they ended up being unable to heat their homes, and suffer ill-health or worse?

This question can be answered in a variety of ways. Firstly, because carbon rationing would become an important part of everyday life, it seems reasonable to suggest that people would swiftly learn to manage their ration. In order to be able to afford energy throughout the year, people already have to manage their money. Help and support is available for those who have difficulties with affording their energy bills (including measures such as debt counselling and pre-payment energy meters), and parallel services could be available to those who found managing their carbon ration problematic. There would have to be mechanisms in place to allow people access to vital energy services whilst at the same time recovering the carbon ‘debt’ over time.

Another answer to this concern is that because carbon rations are tradable, there is no absolute limit on consumption, and if people could afford it, they could simply buy more carbon rations to meet their needs.

Finally, it is important to remember that a lot of carbon emissions come from activities which are not nearly so vital (or as emotive) as using energy to stay warm in winter. For example, over one fifth of land-based travel in the UK (by distance) is for the purpose of seeing friends and another fifth is used for shopping, sport and entertainment (DfT 2003b). Leisure air travel is responsible for adding as much to global warming as all land travel for the average UK citizen. While no doubt important socially, reducing travel for these purposes would not be a matter of life and death.

Putting all the responsibility on the individual

Carbon rationing puts all the responsibility for carbon emissions from personal energy use onto the shoulders of individuals. However, manufacturers, energy companies, retailers, house builders, plumbers and many other professions and industries have an influence on an individual’s carbon emissions. For example, the carbon intensity of electricity is very largely determined by government and the energy

industries, yet it would be the householder who faces the consequences. Would the many other actors in the process which translates an individual's desire for energy or travel services into carbon emissions avoid their share of responsibility under personal carbon rationing?

While locating all the responsibility with individuals may allow other actors to escape their responsibilities, it is undeniable that individual choices are very important in determining and potentially reducing carbon emissions. Some technology choices can be mandated by government, nevertheless individuals and households make key choices about the use of technologies. For example, the government can make efficient boilers compulsory at the point of purchase, but it can't regulate thermostats in people's homes or determine their heating patterns. Under carbon rationing, manufacturers and retailers will compete to sell low carbon emissions products and all of society and its economic processes should be re-oriented towards low carbon solutions. Thus, although the individual has to manage his or her own carbon ration, it will be in the other actors' best interests to enable people to make low carbon choices.

Many authors argue that consumption is a social rather than an individual process (e.g. Shove 2003). Although carbon rationing focuses on the individual, in fact it would fit in with this understanding, because it is a framework which would affect the whole of society. It does not call for heroic personal sacrifice in opposition to mainstream trends.

Problems with not including goods and services

The personal carbon ration does not cover the carbon embodied in goods and services, so purchasing, say, mange tout air-freighted from Kenya, which have high associated air miles and carbon emissions, would not involve the purchaser giving up any of their ration. In theory, it might be possible to calculate the 'embodied' carbon in each product or activity (i.e. the carbon used to produce an apple, stereo equipment or car) and give consumers a further allowance to be used when buying products. However, this would be both extremely complex and data-intensive for goods, and even more difficult, if not impossible, to apply to services (Fawcett et al 2002). It would be much simpler to make the non-domestic sector directly responsible for reducing their share of carbon emissions (Starkey and Fleming 1999). As carbon emissions in the other sectors would also be controlled, the price structure should alter in favour of low embodied carbon goods and services.

CONCLUSIONS

The UK needs a new approach to guarantee achieving carbon savings in the domestic sector and the economy as a whole. The national target set just a few years ago for reductions by 2010 is likely to be missed by a considerable margin. This is before considering the carbon equivalent emissions from international air travel. When these are added to the UK's total, current carbon equivalent emissions are very similar to those in 1990: no reductions have been made. For the domestic sector, energy efficiency is largely being relied on to deliver energy and carbon dioxide savings. However, efficiency has a poor track record at leading to energy conservation – reductions in energy use- and there is no reason to believe it could deliver significant savings in the future.

Carbon rationing is designed as a policy which will enable the UK to make national savings as its contribution within a global agreement on limiting greenhouse gas emissions. It is based on the same principles as those underlying contraction and convergence. It offers a framework for carbon savings which is a constructive alternative to the current policy approaches. Rationing offers an egalitarian approach to sharing the right to emit carbon dioxide to the atmosphere, while allowing people to buy and sell emissions as their preferred lifestyle allows. This policy would require many changes in helping people understand the carbon impacts of their purchases and actions, and some information mechanisms have been identified. It would deliver a society and economy oriented towards low carbon solutions. Carbon rationing represents a way of achieving the government's 60% reduction target by 2050 for half of UK energy use.

Carbon rationing might be thought unrealistic, but the current alternatives could equally be described, in George Monbiot's phrase, as 'hopelessly realistic'(Monbiot 2004). Hopeless in that they are an inadequate means of achieving change, and that they reflect an absence of hope. Carbon rationing is a policy founded on optimism about the future and a belief in the necessity of radical measures to significantly reduce the UK's emissions. It could apply equally in other developed nations. Rationing represents a realistic framework for the changes that will be required if the worst excesses of climate change are to be avoided.

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